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INFRARED ROCKET ASTRONOMY

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Contract Monitor: Stephan D. Price
Optical Physics Laboratory

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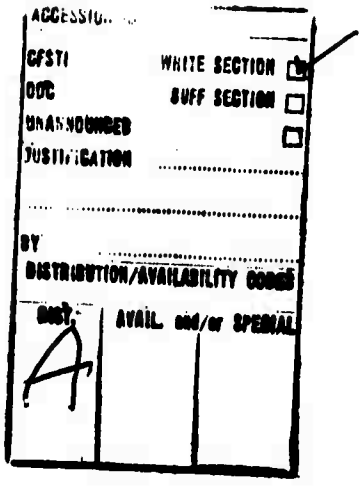

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13. ABSTRACT

This report describes the work completed between 11 December 1970 and 10 May 1971, and is divided into seven sections;

A) Performance of the Reassembled Telescope System

B) The New Optical System

C) Results of December 2, 1970 Flight: Short Wavelength Detectors

D) Results of December 2, 1970 Flight: Long Wavelength Detectors

E) Ground Based Effort

F) Personnel

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A) Performance of the Reassembled Telescope System

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E) Ground Based Effort

F) Personnel

G) Publications

A) Performance of the Reassembled Telescope System

The telescope system was reassembled following the December 2, 1970 flight and calibrated using a black body radiation source.[1] The following results were obtained:

Channel Number	Wavelength Range	NEP (system)	NEFD
1	5-6μ	2×10^{-14} watts $H_z^{-\frac{1}{2}}$	10^{-16} w/cm^2 $H_z^{-\frac{1}{2}}$
2	12-14	2×10^{-14} " "	10^{-16} " "
3	16-22	2×10^{-14} " "	10^{-16} " "
4	70-130	4.5×10^{-13}	4.5×10^{-15}
5	200-300	9×10^{-12}	4.5×10^{-14}
6	300-1300	2×10^{-12}	10^{-14}

The sensitivity figures listed above are for the entire telescope system. As such they do not include corrections for filter or chopper losses. These tests were performed shortly after the recovered payload returned to Cornell University.

Subsequently the optical design of the telescope was changed in order to produce reduced off-axis light sensitivity. This was done using the optical system described in section B. Using the detectors previously flown, the system sensitivity was again tested and found to be substantially identical to that given in the above table.

1) J.R. Houck and M.O. Harwit, Science 1271, 164 (1969).

B) The New Optical System

A new optical system was designed. Its primary purpose was to make the detectors less sensitive to off-axis earth shine.

Radiation incident on the primary mirror is reflected off a flat secondary and impinges on a tuning fork chopper placed at the telescope's focus. It then is collimated by a paraboloid and brought to a second focus by means of an identical second paraboloid. Light cones whose openings lie in this second focal plane then funnel radiation to the six individual detectors whose fields of view are arranged in a row. Individual fields of view are $1\frac{1}{2}^{\circ}$ wide with a length of $\frac{1}{4}^{\circ}$ for detectors 1 thru 4 and 1° for detectors 5 and 6 (See Table in section A). The system's focal ratio is f/0.9.

The off-axis rejection has been measured using visible light. A direct comparison with the previous off-axis rejection is difficult because the primary contribution to light scattered into the field of view comes from fine scratches on the surface of the parabolic mirrors. The set of metal mirrors now in use shows a network of very fine scratches and we hope that the second set to be delivered will have improved surface characteristics. Our previous primary mirror had better surface quality than the new one, but the new system shows comparable off-axis rejection. With the better mirrors to be delivered, considerable improvement over our previous rejection capabilities may be anticipated.

C) Results of December 2, 1970 Flight: Short Wavelength Detectors

These results are presented in full in the final data report which contains the text of a paper entitled: "Rocket Infrared Observations of the Interplanetary Medium" by Baruch T. Soifer, J.R. Houck and Martin Harwit. This paper has been submitted for publication in Astrophysical Journal Letters.

D) Data Analysis of December 2, 1970 Flight: Long Wavelength Detectors

These results are presented in full in the final data report which contains data reported in a paper entitled 'Submillimeter Observations of the Night Sky Emission Above 120 Kilometers' by Judith L. Pipher, J.R. Houck, Barrie W. Jones and Martin Harwit. This paper has been accepted for publication in the journal Nature.

E) Ground Based Observations

The ground based photometer was field tested on the Yerkes Observatory 41 inch telescope in early February. We were rather unlucky with the weather. However, we had one reasonably clear night and did gain valuable experience. Jupiter, α Ori, and α Boo were detected with no difficulty. The relative stellar intensities were consistent with published data, however Jupiter was brighter than expected. Perhaps the sky transparency was changing during the night. Jupiter was the last object to be observed and we do not have a star calibration after it. Observations were also made of NGC6210. No measurable flux was detected and we can only set an

upper limit of about 100 fu. The sensitivity of the observations was limited by both long and short term fluctuations in the atmospheric emission. Even during the clearest periods, the sky noise was much larger than the instrumental noise. The 10μ band is typically noiser than several of the other bands, but we chose to try it first just for the experience. We also had a 20μ filter along, but there was not enough time to use it.

Although the system was sky noise limited, we are redesigning the chopper in order to decrease the microphonic coupling between the chopper and the detector.

F) Personnel

Name	Function or Areas of Responsibility	Support
M.O. Harwit	Project Scientist	Part Time
J.R. Houck	Project Scientist	Part Time
J.L. Pipher	Long Wavelength Detectors	Part Time
B.T. Soifer	Short Wavelength Detectors	Part Time
J. Stasavage	Technician	Part Time

G) Publications

B.T. Soifer, J.R. Houck and M. Harwit, "Rocket Infrared Observations of the Interplanetary Medium", submitted to Ap.J. Letters.

J.L. Pipher, J.R. Houck, B.W. Jones and M. Harwit, "Submillimeter Observations of the Night Sky Emission Above 120 Km", to be published in Nature (1971).